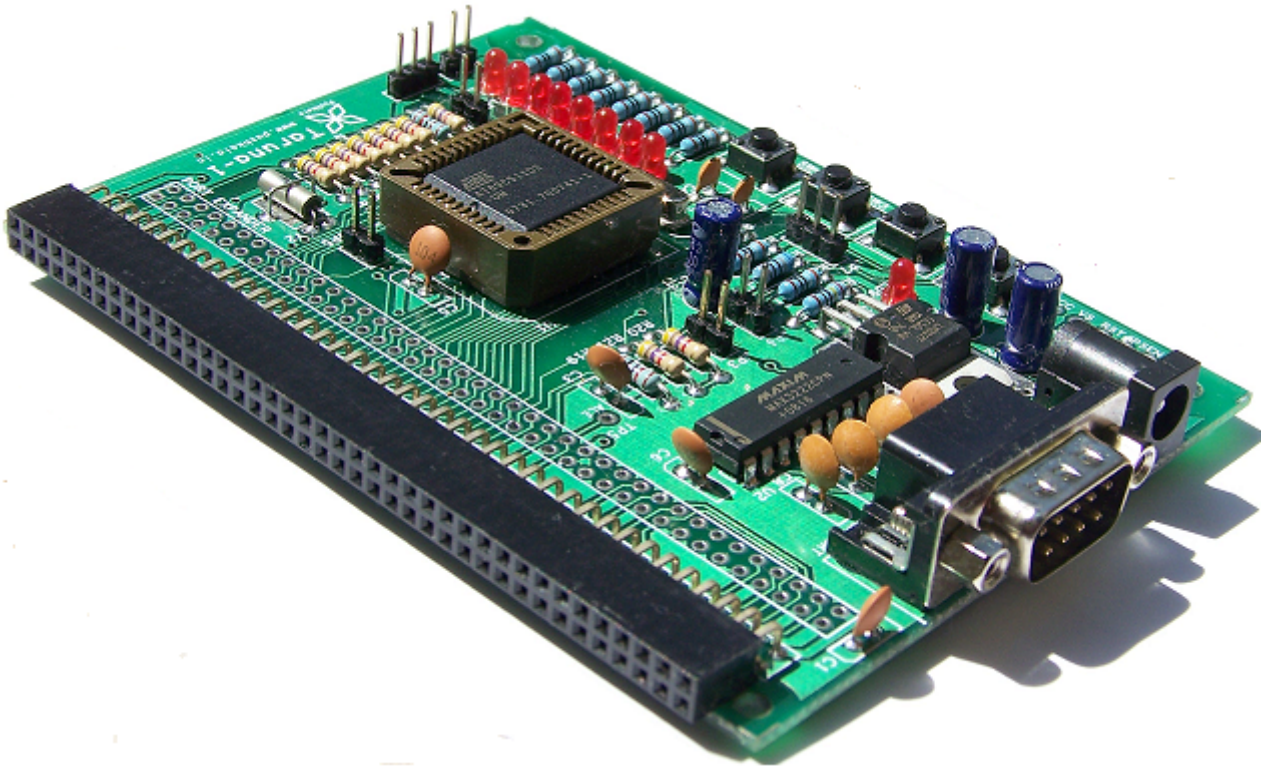
Pushkala™

Taruna - 1

An 8051 Microcontroller Development Board



User Manual

Version 1.0

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About this manual:

This manual intends to discuss about the features, and usage scenarios of Taruna–1, an 8051 microcontroller development board.

Audience:

Any person who wishes to use Taruna – 1.

Conventions used:

`Courier New` font to represent code snippets and commands at prompt.
Tip: Useful information related to topic of discussion.
Warning!: Less severity information
Note: Information which should be considered.

Acronyms used:

KB	Kilo Bytes
XRAM	External Data Memory in form of RAM
EEPROM	Electrically Erasable Programmable Read Only Memory
UART	Universal Asynchronous Receiver Transmitter(Serial Port)
SPI	Serial Peripheral Interface
TWI	Two Wire Interface(similar to I2C)
I2C	Inter Integrated Circuit Communication from NXP
ADC	Analog to Digital Conversion
DAC	Digital to Analog Conversion
CAN	Controller Area Network from BOSCH
GPIO	General Purpose Input Output
PWM	Pulse Width Modulation
bps	Bits per second

Table of contents

Taruna – 1 kit contents

A standard packaged Taruna – 1 kit consists of the following:

1) Taruna – 1 development board
2) Null modem cable
3) DC power adapter
4) User manual CD with other relevant documentation
5) Invoice of Purchase, which is also a legal packing list
6) Any other peripheral modules ordered along with Taruna - 1

Introduction to Taruna – 1

Taruna – 1 is an 8051 development board designed around Atmel's AT89C51ID2 high performance 8051 device variant. It contains 64KB of on chip Flash and 2KB of internal RAM(inclusive of standard internal and XRAM). For non-volatile data storage 2KB of on chip EEPROM is also available. The device can operate up to a maximum clock frequency of 60MHz. AT89C51ID2 is a peripheral rich microcontroller, which comes with UART, SPI, TWI, Keyboard interface, GPIO, PWM, and many other embedded on chip. For further details on this device, please refer to the datasheet of AT89C51ID2 available at Atmel's website.

Taruna – 1 can be considers as a Single Board Computer[SBC] for the reasons that, the basic required functionality to develop a simple Embedded control system is readily available on board. Eight on board LEDs help a developer in displaying/debugging the status of code/program. Basic UART is brought out as a RS232 serial port for PC connectivity and In system Programming[ISP]. All peripheral interfaces are brought out to an easily accessible I/O Port Expander Connector(further section of this document explains these in detail). For external peripheral compatibility the SBC can be powered at either 5VDC or 3.3VDC. Following block diagram gives a glimpse of Taruna – 1's architecture.

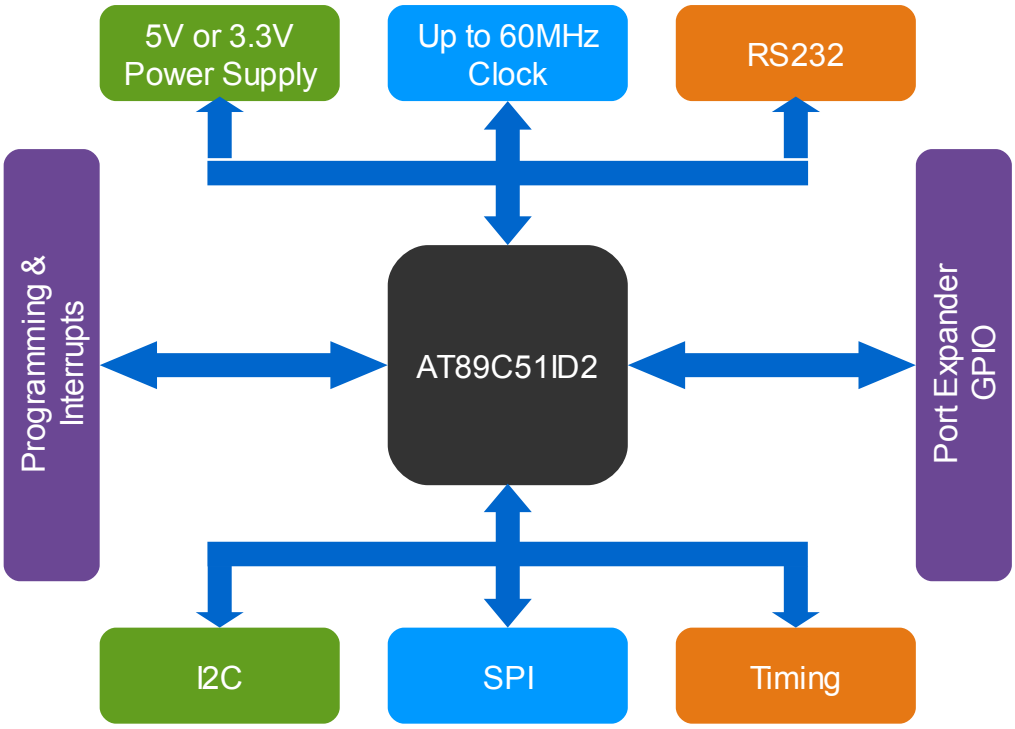


Figure – 1: Block diagram of Taruna – 1

One can increase the capability of Taruna – 1 through its external add-on peripheral modules. Currently ADC, DAC, RTC, LCD, Keyboard, and CAN modules are available.

Identifying what is on board

Figure 2 is the top side view of Taruna – 1, and the accompanying legends identifies the main components on board.

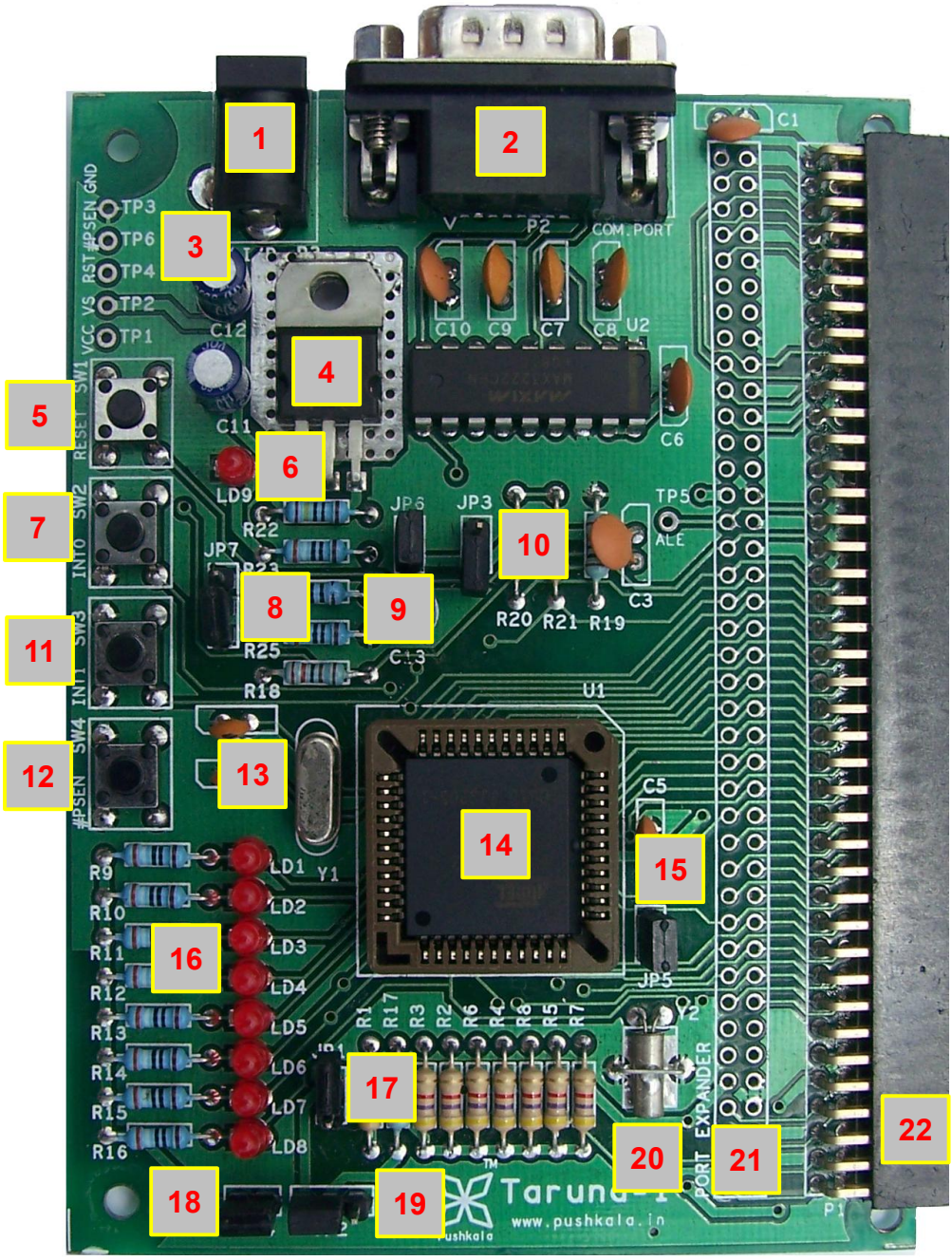


Figure – 2: Top view of Taruna – 1

Legend #	Description
1	DC input power jack
2	DB9 Male connector for RS232 serial communication
3	Various test points(refer Trouble Shooting section for details)
4	Power supply voltage regulator IC
5	Reset Switch
6	Power LED
7	Active low Interrupt 0[INT0] switch
8	Jumper 7[JP7]
9	Jumper 6[JP6]
10	Jumper 3[JP3]
11	Active low Interrupt 1[INT1] switch
12	Program Store Enable Switch[PSEN]
13	Primary clock crystal – 22.1184MHz
14	AT89C51ID2 microcontroller
15	Jumper 5[JP5]
16	LED array connected to Port 2
17	Jumper 1[JP1]
18	Jumper 4[JP4]
19	Jumper 2[JP2]
20	Sub clock crystal – 32.768KHz
21	Port Expander pads
22	P1 I/O Bus connector

Basic Development Setup

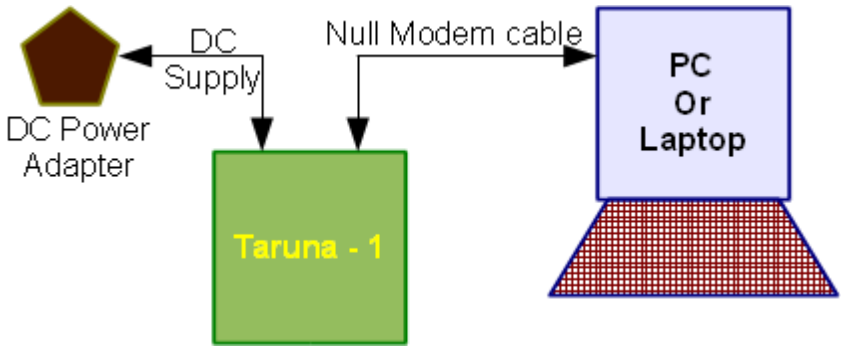


Figure – 3: Setup of cross development environment.

Setting up development environment is very simple. Plug in the supplied Null Modem Cable's one end to Taruna – 1's “DB9 connector” as described in previous section(RS232 Connector), and the other end to PC's serial/com port.

To power up the board just plug-in the DC power adapter's DC jack to “DC input power jack” on Taruna – 1 and the 230V pins to the socket and power on.

Read through further sections to know about software required for cross development and a quick test scenario.

Warning!: Not all PCs or Laptops have serial port/s built in. Arrange a USB to Serial converter in that case.

Quick Check

This section describes about how to test your Taruna-1 board on first power up.

1. Connect the Taruna-1 as per the guidelines given in the previous section.
2. Open Minicom in GNU/Linux or Hyper Terminal in WindowsXP or similar serial communication utility of your choice.
3. Setup the serial communication utility with following parameters:
    - Baud Rate = 9600bps
    - Data bits = 8
    - Stop bits = 1
    - Flow control = None
4. Power up the board.
5. You should see “Taruna-1 Ready” on your serial communication utility.
6. Now press key from 1 to 8 on your PC, corresponding LED will switch on.
7. Press 0 to switch off the glowing LED.

This completes the test, and now the setup is are ready to be explored.

If in any case you do not succeed with the above steps immediately contact support@pushkala.in and report the problem. Make sure your email subject is specified as Taruna-1<serial number(SN) as specified on your board>.

Note: Once you reprogram(download your code) the board, you can not run this test again. This is factory programmed test code and will be erased once you program the board with your code.

Software Setup

Compiler – SDCC

Small Device C Compiler – SDCC is an Open Source C Cross Compiler used for compiling or generating binary executable files in Intel Hex format for the Taruna-1 board. Current version of the same is supplied on the CD accompanying the development board. To download the latest version log onto http://sdcc.sourceforge.net/

Installation details are available in the SDCC user manual, install accordingly on your favorite Operating System.

Tip: There are many IDEs which support SDCC as an add-on compiler, to help development of 8051 programs. You may explore one if interested. Else a simple text editing tool and command prompt is sufficient to do the job!

Note: Usage of a cross compiler or developing 8051 programs in C or assembly is beyond the scope of this document. Refer to Useful Information of this document to get related information.

Downloading utility – FLIP

To download the executable on to the microcontroller, in our case AT89C51ID2, Atmel provides an easy to use GUI based programming utility called FLIP. Current version of FLIP is distributed on the CD accompanying the development board. To download the latest version log on to http://www.atmel.com/.

Installation is self explanatory. Install one instance on your favorite OS and get ready to program. Usage details will be discussed in the following section.

First Program on Taruna1

Developing a simple LED toggling code

Step – 1: Key in the following code in your favorite text editor and save as ledtoggle.c

```
/*
 * File             : ledtoggle.c
 *
 * Date             : 28-06-2010
 *
 * Author           : Pushkala <support@pushkala.in>
 *
 * Description      : This program toggles one Red LED on
 *                    Taruna - 1 board.
 *
 * Version          : 0.1.0
 *
 * Modificatios     : No modifications yet
 *
 */


/* Include SFR declarations header file */
#include <8051.h>
#include <8052.h>
#include <at89C51ed2.h>

#define MAX         30000
#define FOREVER     1

/* allocate green LED: '1' = ON; '0' = OFF */
#define LED    P2_0
#define LED_ON P2_0 = 1
#define LED_OFF     P2_0 = 0

void softDelay(unsigned long count);

void main ( void )
{

     /*Clear Port 2*/
     P2 = 0;

     /* forever */
     while ( FOREVER )
```

```
     {
          softDelay(30000);
          /*LED = 1;*/
          LED_ON;

          softDelay(30000);
          /*LED = 0;*/
          LED_OFF;
     }

}

void softDelay(unsigned long count)
{
     unsigned long i = count;

     for ( i = MAX; i > 0; i-- );

}
```

Step – 2: Compile the saved c file using sdcc command, example shown below.

```
Prompt->sdcc ledtoggle.c
```

On successful compilation you will observe many files created with name ledtoggle but with different file extensions. File with .ihx or .hex extension is the one which should be downloaded on to the uC. Next section describes about how to program the uC.

Tip: Study the SDCC user manual to know more about various compilation options.

Downloading and testing

1. Open the FLIP utility, make sure Taruna – 1 is connected to your Laptop/PC via the Null Modem cable.
2. Click on “Select Target Device” icon to select AT89C51ID2.
3. Click on “Load HEX File” icon to browse and select ledtoggle.ihx file.
4. Power up the board using the supplied DC Power Adapter.
5. Take Taruna – 1 to programming mode by following the below mentioned key press sequence on board:
    a. Press and hold the PSEN key (SW4), do not release! the key.
    b. Now Press and release the RESET key (SW1).
    c. Release the PSEN key now.
6. Establish communication between FLIP and Taruna – 1 by clicking “Select a Communication Medium” icon. Select RS232.

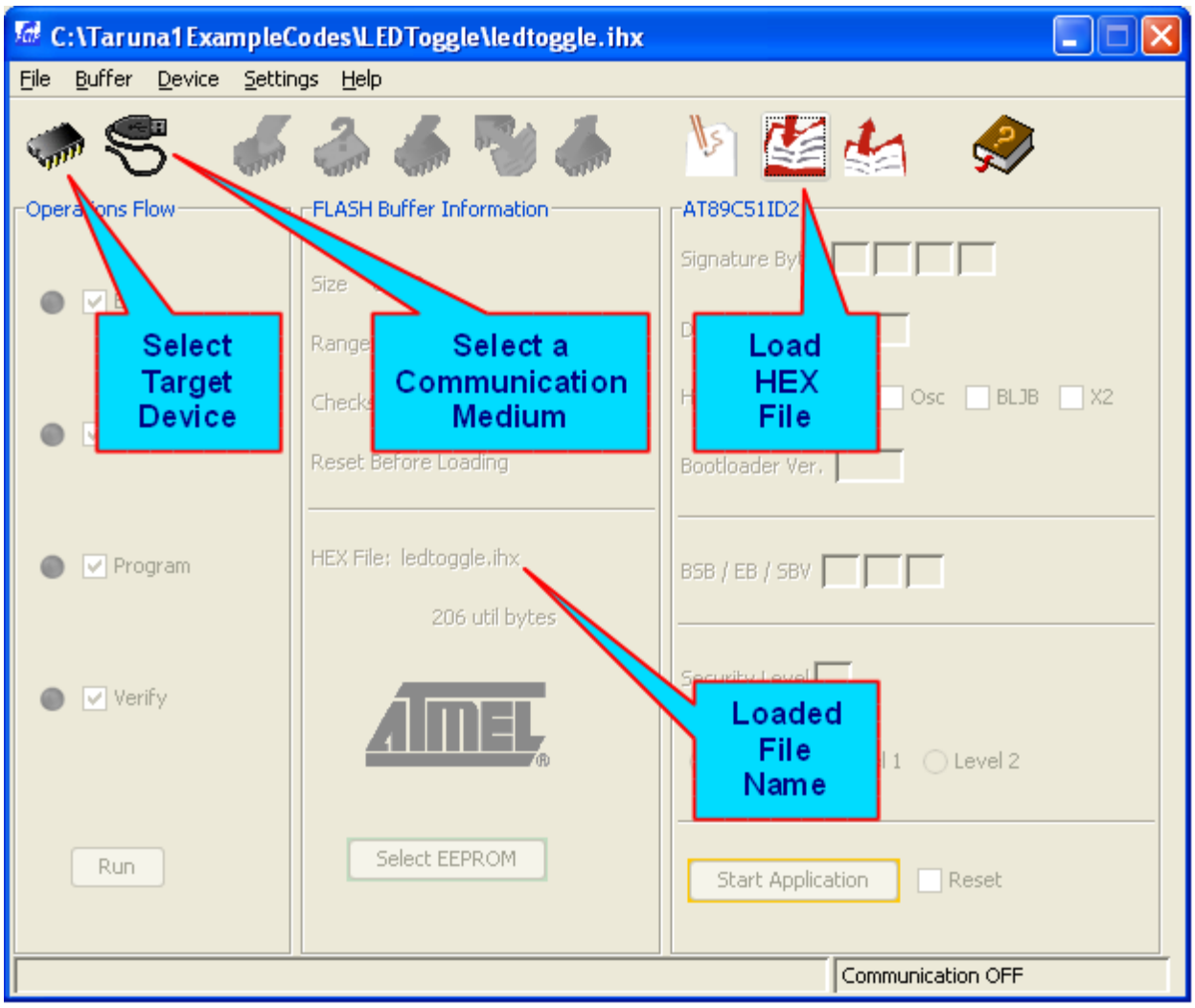


Figure – 4: FLIP main screen.

7. Select appropriate comport available on your Laptop/PC and click “Connect”.

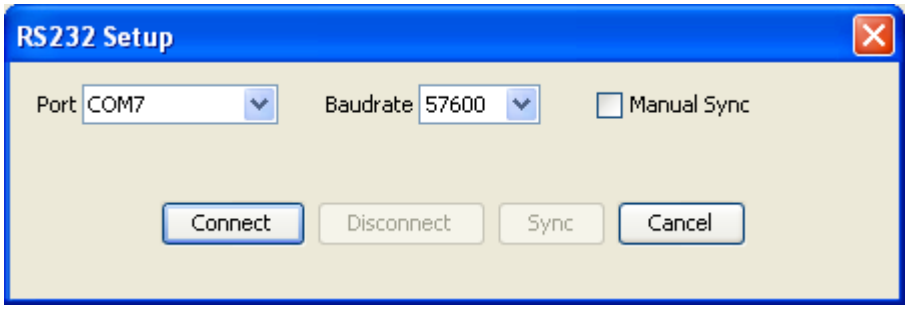


Figure – 5: Communication port selection pop up window.

8. On successful connection you will see all the masked icons and information will be unmasked. Now click “Run” icon to program the uC.

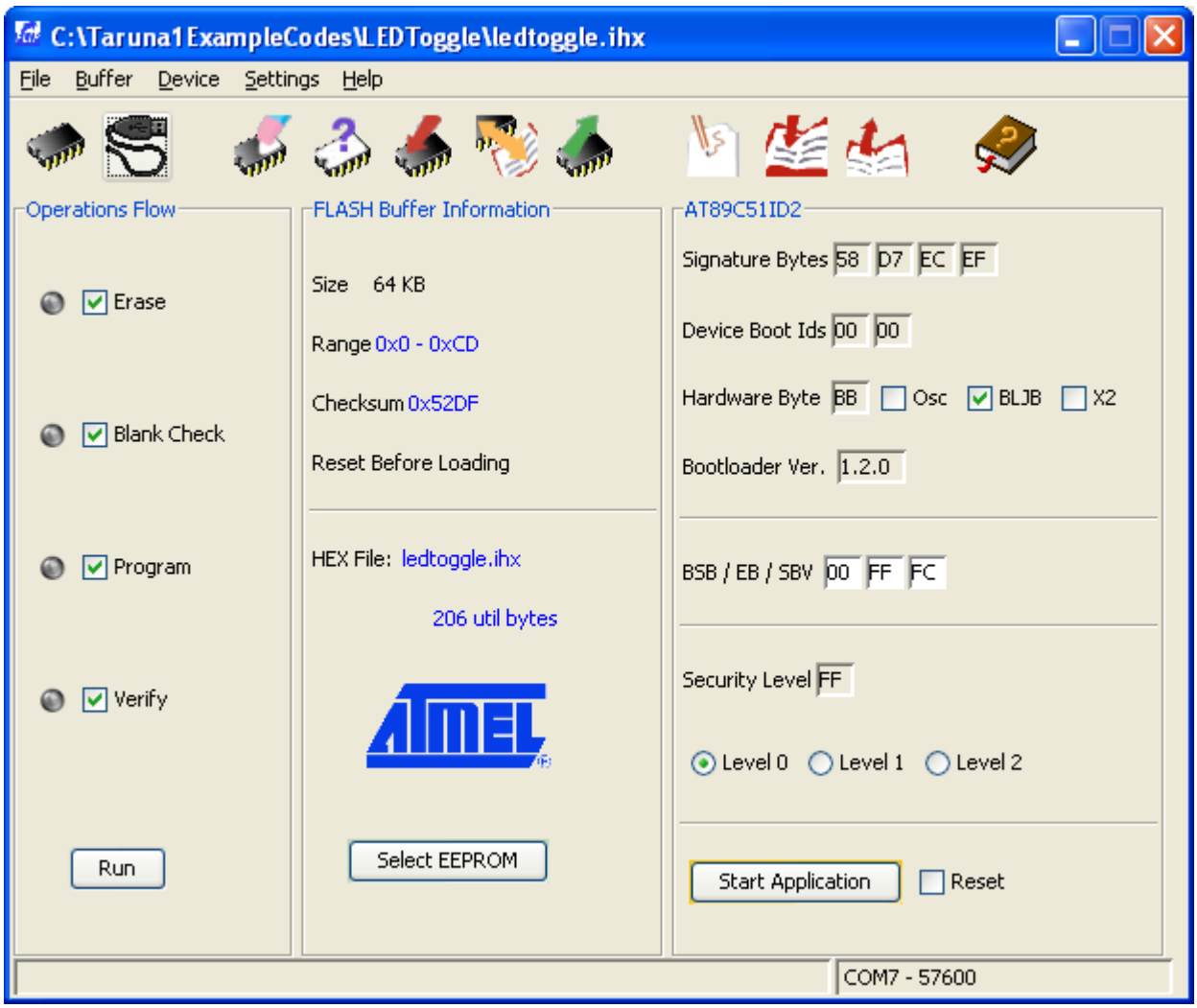


Figure – 6: FLIP ready for programming.

9. After successful programming you may observe the Green color buttons next to the activities which were carried out during programming.
10. Now click “Start Application” icon or press RESET key on board to launch the application.

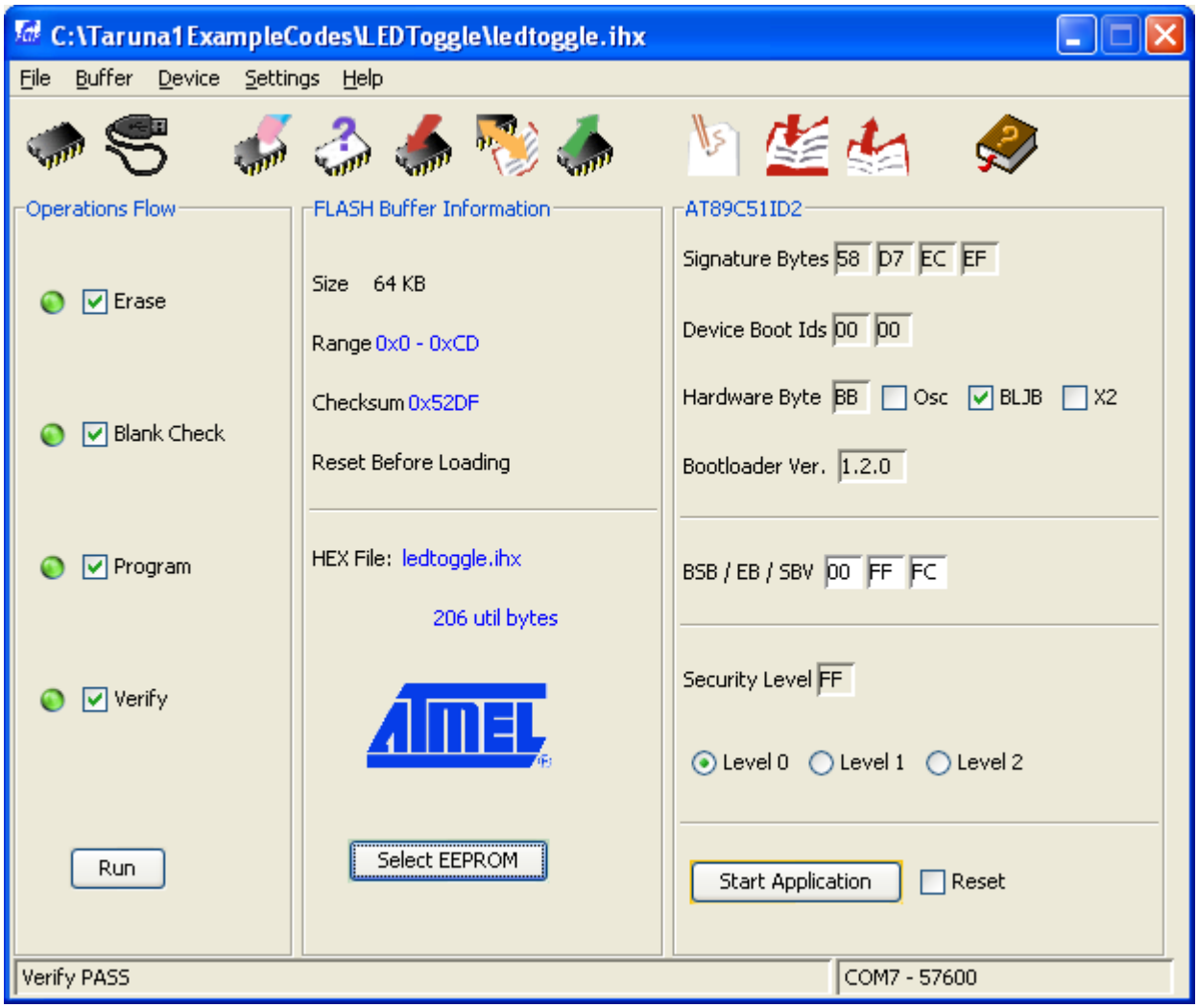


Figure – 7: FLIP screen depicting successful programing state of uC.

Note: Do not alter any other parameter in the FLIP utility. If attempted you may loose the programming ability of the device.

Tip: Look out for other example codes in the CD or log on to www.pushkala.in

Jumper settings

There are seven Jumpers[JP1 to JP7] to configure various settings of Taruna – 1. This section gives you an insight about various settings using respective Jumpers.

These jumpers are either two pin or three pin variants. In each jumper the pin with square pad is Pin 1 and other are in order 2 and 3, as shown in figure below. The black thick line next to the pad pin represent the presence of a short link. Short link is simple two pin conductive connector. Short links are provided for all jumpers even though in some they are not utilized.

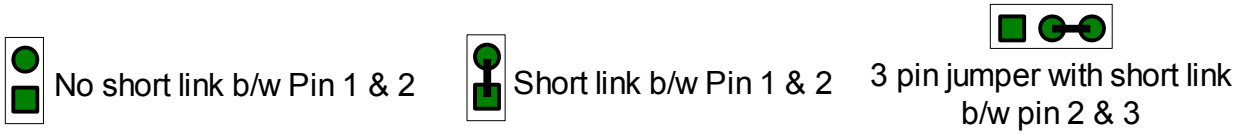


Figure – 8: Jumper connection schemes

Jumper 1[JP1]: Enable/Disable Port-1 pull-up resistors.
Each pin of Port-1 of AT89C51ID2 is connected with a 390ohms pull-up resistor. Using JP1 one can enable or disable these pull-resistors.
Standard Setting: Disabled

Short link between Pin 1 and 2	Enabled
No short link between Pin 1 and 2	Disabled

Jumper 2[JP2]: Select Program Memory.
AT89C51ID2 provides an option to interface external program memory addressable up to 64KB, this option is selectable by asserting the EA pin to logic 0.
Using JP2 one can switch between internal/on-chip program memory or external program memory.
Standard Setting: Internal Program Memory

Short link between Pin 1 and 2	Internal Memory
Short link between Pin 2 and 3	External Memory

Jumper 3[JP3]: Enable/Disable TWI pull-up resistors.
The SDA and SCL lines of TWI interface has two pull-up resistors connected to VCC through JP3.
JP3 enables or disables these pull-up resistors.
Standard Setting: Disabled

Short link between Pin 1 and 2	Enabled
No short link between Pin 1 and 2	Disabled

Jumper 4[JP4]: Enable/Disable LED array.
8 LEDs are connected individual pins Port-2 of AT89C51ID2. Using JP4 one can enable or disable this array.
Standard Setting: Enabled

Short link between Pin 1 and 2	Enabled
No short link between Pin 1 and 2	Disabled

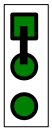
Jumper 5[JP5]: Enable/Disable Sub Clock Crystal.
A 32.768KHz crystal is routed through JP5 to Port1.0 which is also crystal B input pin. JP5 enables or disables this connectivity.
Standard Setting: Enabled

Short link between Pin 1 and 2	Enabled
No short link between Pin 1 and 2	Disabled

Jumper 6[JP6]: Enable/Disable VCC to Taruna – 1.
VCC to complete board can be cut off using JP6. This jumper is in series with voltage regulator output and other Taruna – 1 components.
Standard Setting: Enabled

Short link between Pin 1 and 2	Enabled
No short link between Pin 1 and 2	Disabled

Jumper 7[JP7]: Select Operating Voltage(VCC).
AT89C51ID2 operates any where between 2.7VDC to 5.5VDC VCC. Two standard operating voltages in this range are 3.3VDC and 5VDC. Hence to support peripheral interface at these operating voltages JP7 can be used to switch between 5VDC and 3.3VDC.
Standard Setting: 5V



Short link between Pin 1 and 2	5V
Short link between Pin 2 and 3	3.3V

I/O Expansion Port Details

All the pins of AT89C51ID2 are brought out on to two connecters called P1 and Port Expander. Some of the pins are duplicated and grouped according to some common functionality to aid easy plug-in of add-on modules from Pushkala. P1 and Port Expander are mapped 1:1. User can expand other compatible peripherals through these ports. Information about add-on modules available from Pushkala are published on www.pushkala.in

Look at Figure – 4 to understand the pin grouping and the following table describes about each pin functionality.

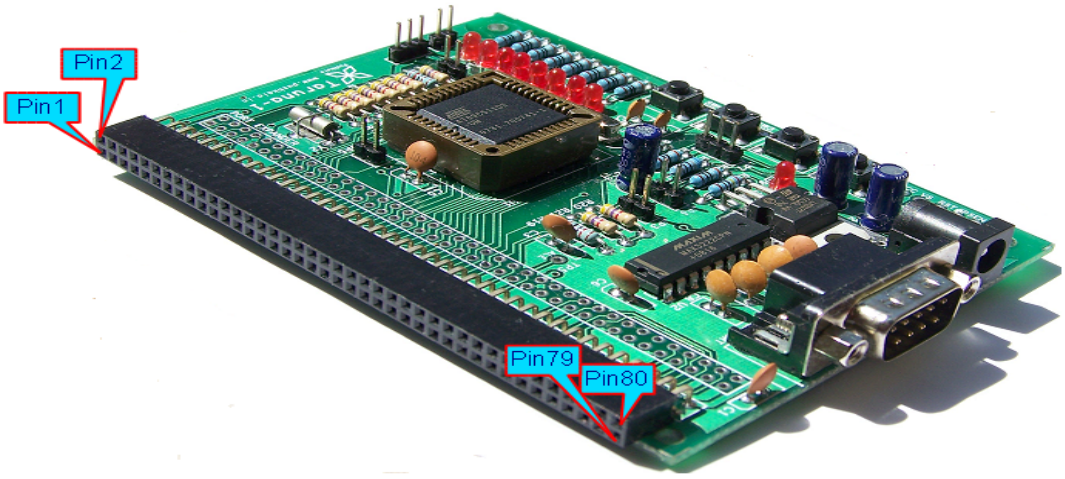


Figure – 9: Pin or Functionality grouping of P1 and Port Expander.

Table describing functionality of each pin on P1 and Port Expander, # means active low:

Functionality	Pin #	Pin #	Functionality
VCC	80	79	GND
SPI – MISO for ADC or P1.5	78	77	GND
SPI – MOSI for ADC or P1.7	76	75	SPI – SCK for ADC or P1.6
SSTRB for ADC or P2.4	74	73	GND
#CS for ADC or P2.3	72	71	GND
No Connect	70	69	No Connect
No Connect	68	67	No Connect
VCC	66	65	GND
SPI – MOSI for DAC or P1.7	64	63	SPI – SCK for DAC or P1.6
LDAC for DAC or P2.6	62	61	GND
#CS for DAC or P2.5	60	59	GND

No Connect	58	57	No Connect
No Connect	56	55	No Connect
VCC	54	53	GND
uC – ALE	52	51	GND
uC – #PSEN	50	49	GND
TWI – SDA	48	47	TWI – SCL
P3.7 or #RD	46	45	P3.6 or #WR
P3.5 or T1	44	43	P3.4 or T0
P3.3 or #INT1	42	41	P3.2 or #INT0
P3.1 or TXD	40	39	P3.0 or RXD
P1.7 or CEX4 or SPI MOSI	38	37	P1.6 or CEX3 or SPI SCK
P1.5 or CEX2 or SPI MISO	36	35	P1.4 or CEX1
P1.3 or CEX0	34	33	P1.2 or ECI
P1.1 or T2EX or SPI #SS	32	31	P1.0 or T2 or XTALB1
P2.7 or A15 or CS for CAN	30	29	P2.6 or A14 or LDAC for DAC
P2.5 or A13 or CS for DAC	28	27	P2.4 or A12 or SSTRB for ADC
P2.3 or A11 or CS for ADC	26	25	P2.2 or A10 or RS for LCD
P2.1 or A9 or R/W for LCD	24	23	P2.0 or A8 or Enable for LCD
P0.7 or AD7	22	21	P0.6 or AD6
P0.5 or AD5	20	19	P0.4 or AD4
P0.3 or AD3	18	17	P2.2 or AD2
P0.1 or AD1	16	15	P0.0 or AD0
No Connect	14	13	No Connect
No Connect	12	11	No Connect
VCC	10	9	GND
P3.3 or #INT1 for RTC interrupt	8	7	GND
P3.2 or #INT0 for RTC interrupt	6	5	GND
TWI – SCL for RTC	4	3	GND
TWI – SDA for RTC	2	1	GND

For further details refer to the schematic of Taruna – 1.

Tip: Refer to datasheet of AT89C51ID2 for more details on microcontroller pins and its functionality.

Schematic

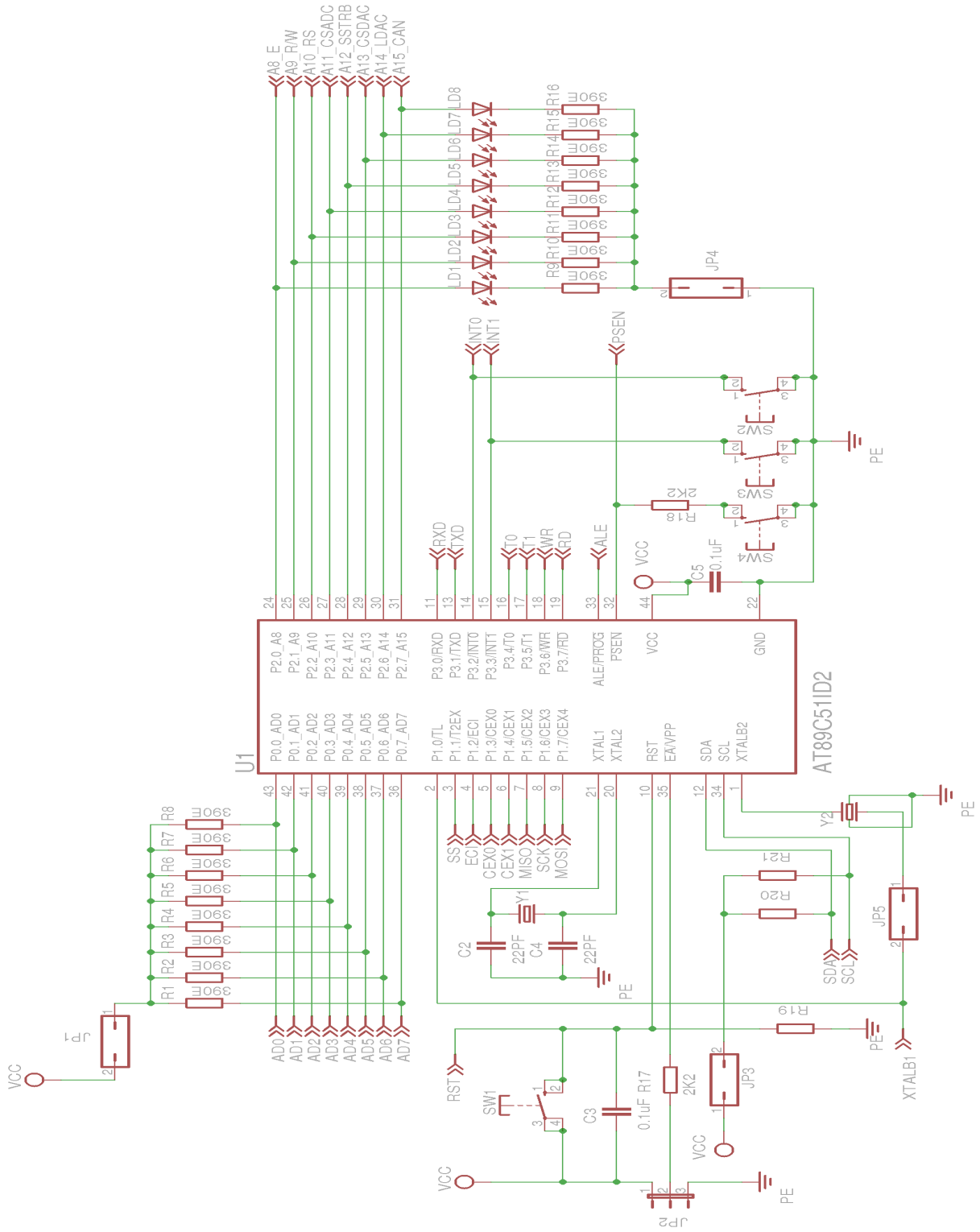


Figure – 10: Microcontroller Schematic.

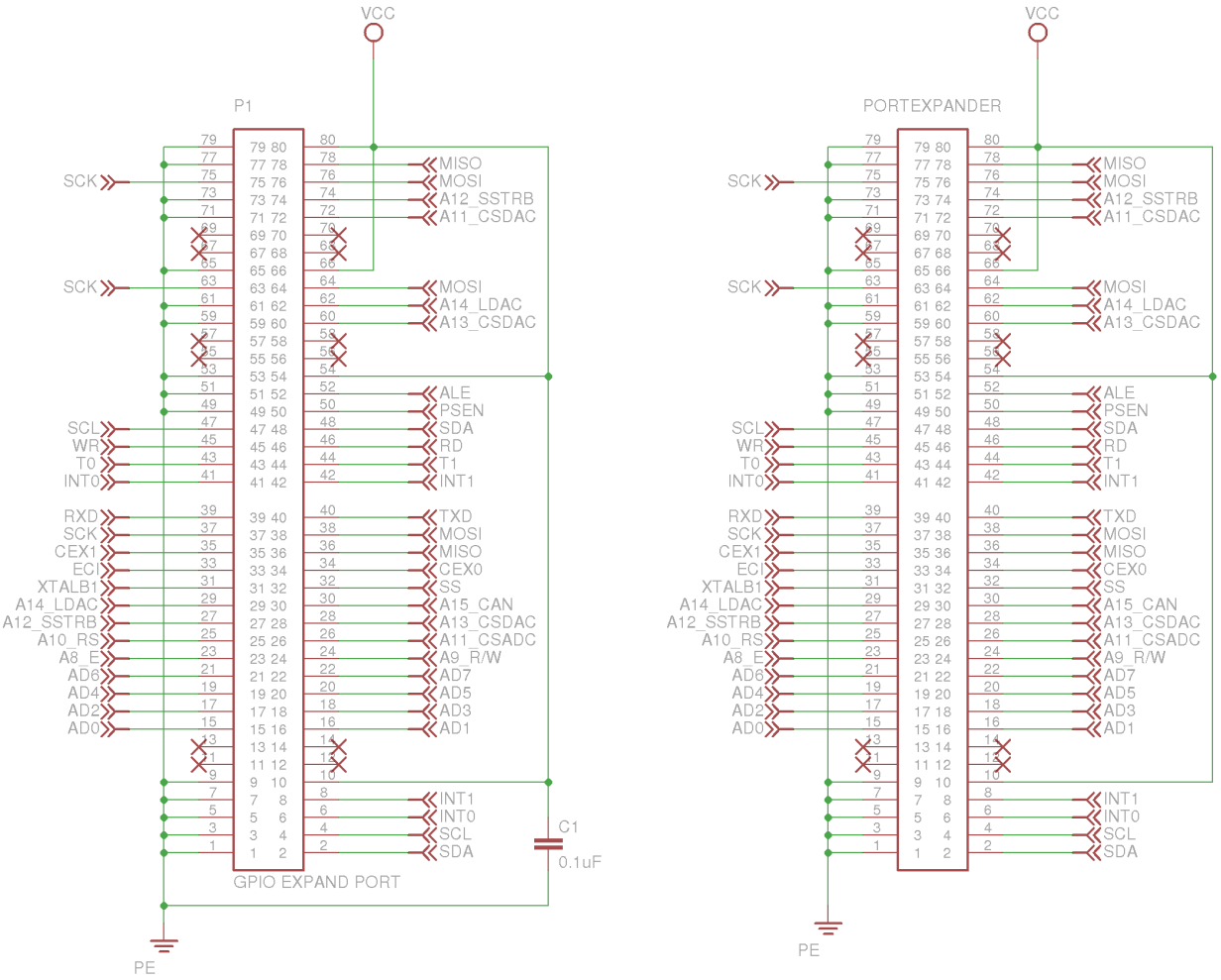


Figure – 11: Port Expander Schematic.

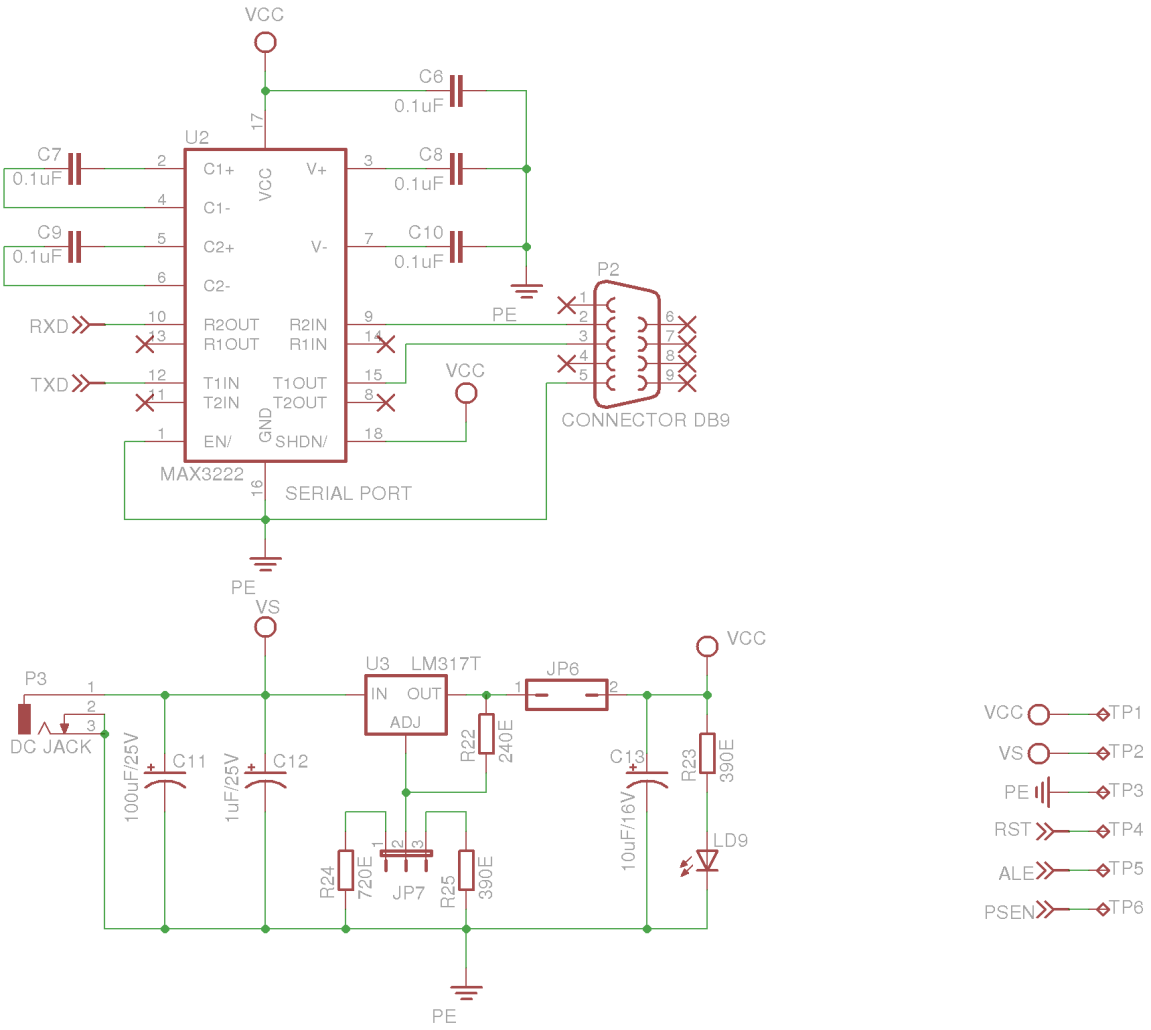


Figure – 12: Power Supply and Communication Schematic.

Contacts

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